Effects of Low Temperature on Operation Efficiency of Tree-Felling by Chainsaw in North China[1]

Wang Yongan (王永安)
Jilin Forestry College, Jilin 132011, P. R. China
Jia Baojun (贾宝君)
Hanjiayuan Forest Bureau, Daxing an Mountain Region, Heilongjiang

Abstract. Comparison method and video-tape recorders were used in case study for recording the operation performances of two group operators. The time span was 7 months, from September to March. The performance of operations in September was taken as references. The results of test survey and data analysis showed that the tree-felling operation efficiency was influenced by cold weather, properly decreased 18.5% in average.

Key words: Cold working environment, Operation efficiency, Tree-felling, Ergonomics considerations.

Test Site

Most of tree-felling operations in north China are conducted in the low temperature environment, ranging from -10 °C to -25 °C, properly from November to March of next year. The test site is located in Dailing Forest Bureau(46°50′ 9″ N latitude and 128°37′47″ E longitude), Heilongjiang Province, China. It is inland climate. Annual precipitation there is around 600 mm and elevation is 620~650 m above sea level. The slope at test site is 10.8 degrees in average. Forest coverage is about 95%, Forest type is a mixture of conifer and broadleaf trees. Selective cutting was the prevailing cutting method.

Survey Method

Two groups of skilled operators using the 051-chainsaw which was domestically manufactured, were surveyed during the test time span, from September to March of next year. Two video-tape recorders were used for recording the performances of these operators. And diameter ruler and 100 meter-ruler were employed for measuring the trees' diameters and the distances between trees to be cut respectively. Air temperature and humidity were read from the Centigrade thermometer and humidometer. The depth of ground snow was measured by the simple ruler. The precipitation data were obtained from the local meteorological observation station. A moderate weather day was chosen during the test period in order to reduce the influence from other weather factors, such as strong wind and heavy rainfall. The weather data were recorded twice a day before and after recording operations.

Results and Discussions

The data concerning the working environment of tree-felling at testing site from September to March were shown in Table 1. The operators traveled much slowly during the cold period(from November to March), with comparisond to that in September(Table 2). This is mainly due to: (1) operators weared more clothes and have more difficulties to move from one tree to another; (2) more snow on the ground of operation site in winter period also produces much more resistance in moving to operators.

The operations of tree cross-cutting for a operator includes preparation, starting, moving chainsaw aiming at the cut, cutting, and moving around the tree. Although the efficiency for cutting the standing trees in frozen state is of 10% higher than that in normal state, the total operation efficiency of cross-cutting decreased(Table 2). The reasons were: (1) Long time exposed to cold weather, operators were too cold to perform the operations. Low temperature made operator's arms and legs and even fingers more stiff than that under normal temperature (approximately 10 °C). They

[1] This paper is supported by Project of Optimal Environmentally Sound Harvesting Model

had difficulties to handle the chainsaw. (2) Preparation time increased significantly due to more snow around the trees and more cleaning work. (3) The breakdown frequency of chainsaw was higher.

Table 1. Micro-environment of tree-felling operations during testing time span

	Average Temperature (℃)	Lowest Temperature (℃)	Precipitation (mm)	Depth of Snow (cm)	Humidity (%)
September	11.7	-2	86.5	0	77
October	2.9	-11	32.2	0	73
November	-10.0	-25	10.7	10	71
December	-20.9	-36	7.9	25	70
January	-24.0	-39	5.2	45	71
February	-19.1	-28	4.2	40	69
March	-8.6	-26	10.3	35	64

Table 2. Results of test survey and data analysis

	Sep.	Oct.	Nov.	Dec	Jan	Feb.	Mar
Velocity (percentage) (m/h)	2890 (100)	2540 (88)	1950 (67)	1800 (62)	1820 (63)	1880 (65)	1920 (66)
Deduction of cross-cutting efficiency (%)	0	2.2	6.5	15.9	18.6	16.2	8.1
Frequency of chainsaw's breakdown (times/h)	0.3	1.2	2.5	4.7	5.4	5.0	3.4
Deduction of tree-felling efficiency (%)	0	5.7	16.0	23.9	25.2	23.0	17.4

According to the observations from the survey of testing site, proportion between cutting time and other time including preparation, traveling and breakdown, was approximately 64% : 36%. The deduction of tree-felling operation efficiency at this site could be estimated through the Tree-Felling Efficiency Model[1] as shown in Table 2.

Conclusions

The results of test survey and data analysis showed that the tree-felling operation efficiency was influenced by cold weather, properly decreased 18.5% in average in this case study. Below -20 °C, the lower the temperature was, the more quickly the operation efficiency decreased. It was approved by multi-variable regression model (R^2=0.98) of Tree-felling Efficiency =-0.14 (Average temperature)$^{1.5}$ - 0.01(Precipitation) - 0.62 (Humidity) + 53.86.

The correlation analysis showed that tree-felling efficiency had a high correlation with temperature (-0.97) and precipitation(-0.90), but humidity (-0.65) during the testing period.

References

1. Wang L. 1997. Planning and operations research of timber procurement (Chinese Edition). Beijing: China Forestry Publishing House.

2. Wang L. 1995. Effects of micro-climate on tree-felling operation efficiency. J. of Forest Engineering (Chinese Edition) 11: 32-36.

(**Responsible Editor**: Da Fangtian)